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Product Information

**DATE : 20.Apr.2011****SAMSUNG TFT-LCD****MODEL : LTI460HM01**

The Information Described in this Specification is Preliminary and can be changed without prior notice

|                                     |                     |                                     |                     |
|-------------------------------------|---------------------|-------------------------------------|---------------------|
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|-------------------------------------|---------------------|-------------------------------------|---------------------|

Application Engineering Part , LCD Division

Samsung Electronics Co . , LTD.

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**\* Revision History****Samsung Confidential**

| Date          | Rev. No | Page | Summary                         |
|---------------|---------|------|---------------------------------|
| Jun. 25, 2010 | 000     | all  | First issued                    |
| Apr. 20.2011  | 000     | 22   | Bottom chassis user hole change |

## General Description

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### Description

LTI460HM01 is a color active matrix liquid crystal display (LCD) that uses amorphous silicon TFT(Thin Film Transistor) as switching components. This model is composed of a TFT LCD panel, a driver circuit and a backlight unit. The resolution of a 46.0" is 1920 x 1080 and this model can display up to 16.7 million colors with wide viewing angle of 89° or higher in all directions. This panel is intended to support applications to provide a excellent performance for Flat Panel Display such as Home-alone Multimedia TFT-LCD TV, Display terminals for AV application products, and Digital Information Display (DID).

### Features

- RoHS compliance (Pb-free)
- High contrast ratio, High luminance
- SPVA(Super Patterned Vertical Align) mode
- Wide viewing angle ( $\pm 178^\circ$ )
- High speed response
- Landscape / Portrait type compatible
- FHD(1920 x 1080 pixels) resolution (16:9)
- Low power consumption
- Direct Type 12 CCFTs(Cold Cathode Fluorescent Tube)
- DE(Data Enable) mode
- LVDS (Low Voltage Differential Signaling) interface (2pixel/clock)

## General Information

| Items               | Specification                                    | Unit              | Note     |
|---------------------|--------------------------------------------------|-------------------|----------|
| Module Size         | 1083(W <sub>Typ</sub> ) x 627(H <sub>Typ</sub> ) | mm                | ± 1.0 mm |
|                     | 60.0(D <sub>Max</sub> )                          |                   | ± 1.0 mm |
| Weight              | 12,500                                           | g                 | Max      |
| Pixel Pitch         | 0.53025(H) x 0.53025(V)                          | mm                |          |
| Active Display Area | 1018.08(H) x 572.67(V)                           | mm                |          |
| Surface Treatment   | Haze 44% , Hard-coating (3H)                     |                   |          |
| Display Colors      | 8 bit - 16.7M                                    | colors            |          |
| Number of Pixels    | 1920 x 1080                                      | pixel             |          |
| Pixel Arrangement   | RGB vertical stripe                              |                   |          |
| Display Mode        | Normally Black                                   |                   |          |
| Luminance of White  | 450 (Typ.)                                       | cd/m <sup>2</sup> |          |

## 1. Absolute Maximum Ratings

If the condition exceeds maximum ratings, it can cause malfunction or unrecoverable damage to the device.

| Item                                  |              | Symbol              |     | Min.    | Max. | Unit | Note    |
|---------------------------------------|--------------|---------------------|-----|---------|------|------|---------|
| Power Supply Voltage                  |              | V <sub>DD</sub>     |     | GND-0.5 | 13.2 | V    | (1)     |
| Storage temperature                   |              | T <sub>STG</sub>    |     | -20     | 60   | ℃    | (2)     |
| Glass surface temperature (Operation) | Center       | T <sub>CENTER</sub> |     | 0       | 50   | ℃    | (2),(5) |
|                                       | T.Uniformity | Δ T                 |     | -       | 10   | ℃    |         |
| Shock (Non-operating)                 |              | S <sub>nop</sub>    | x,y | -       | 40   | G    | (3)     |
|                                       |              |                     | z   | -       | 30   |      |         |
| Vibration (Non-operating)             |              | V <sub>nop</sub>    |     | -       | 1.5  | G    | (4)     |

Note (1)  $T_a = 25 \pm 2^\circ\text{C}$

(2) Temperature and relative humidity range are shown in the figure below.

a. 90 % RH Max. ( $T_a \leq 39^\circ\text{C}$ )

b. Relative Humidity is 90% or less. ( $T_a > 39^\circ\text{C}$ )

c. No condensation

(3) 11ms, Sine wave, one time for  $\pm X$ ,  $\pm Y$ ,  $\pm Z$  axis

(4) 10-300Hz, Sweep rate 10min, 30min for X,Y,Z axis

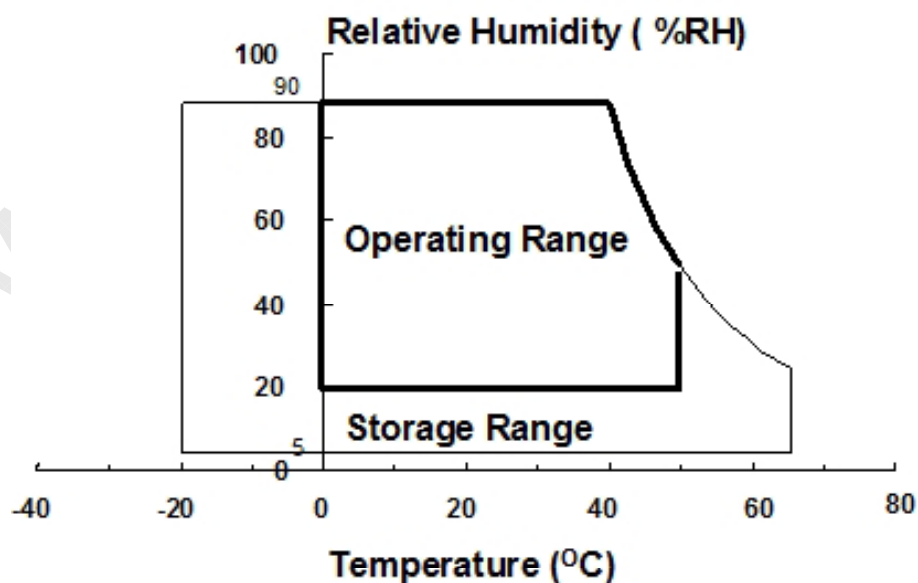
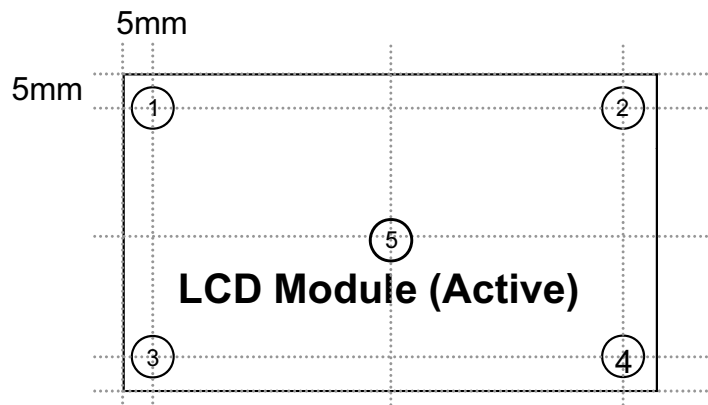


Fig. Temperature and Relative humidity range

## (5) Definition of test point

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$$\Delta T \text{ should be less than } 10^{\circ}\text{C} \quad (\Delta T = |T_{\text{CENTER}} - T_{\text{CORNER}}|)$$
 $T_{\text{CENTER}}$  : Temperature of the center of the glass surface (Test point 5)

 $T_{\text{CORNER}}$  : Temperature of each edge of the glass surface (Test point 1~4)

## 2. Application information for DID (Digital Information Display)

A long-term display like DID application may cause uneven display including image retention. To optimize module's lifetime and function, several operating usages are required.

### 1. Normal operating condition

- Temperature:  $20 \pm 15^{\circ}\text{C}$
- Humidity:  $55 \pm 20\%$
- Display pattern: moving picture or regular switchover display

Note) Long-term static information image may cause uneven display.

### 2. Operating usages under abnormal operating condition. Note (1)

- a. Ambient condition
  - Well-ventilated place is recommended to set up DID system.
- b. Power off and screen saver
  - Periodical power-off or screen saver is needed after long-term static display. Note (2)

### 3. Operating usages to protect uneven display due to long-term static information display

- a. Suitable operating time for B-DID : under 12 hours a day.
- b. Periodical display contents change from static image to moving picture.
  - Liquid crystal refresh time is required.
- c. Periodical background color and character (image) color change
  - Use different colors for background and character (image), respectively.
  - Change colors periodically.
- d. Avoid combination of background and character with large different luminance.

Note (1) Abnormal condition means every operating condition except normal operating condition.

Note (2) Moving picture or black pattern is strongly recommended for screen saver.

### 4. Lifetime in this spec is guaranteed only when DID is used under right operating usages.

### 3. Optical Characteristics

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The optical characteristics should be measured in a dark room or equivalent.

Measuring equipment : TOPCON BM-7, SPECTRORADIOMETER SR-3

(Ta = 25 ± 2 °C, V<sub>DD</sub> = 12V, f<sub>V</sub> = 60Hz, f<sub>DCLK</sub> = 148.5MHz, I<sub>L</sub> = 14.0 mArms)

| Item                                     |        | Symbol           | Condition                                                                    | Min.          | Typ.  | Max.          | Unit              | Note            |
|------------------------------------------|--------|------------------|------------------------------------------------------------------------------|---------------|-------|---------------|-------------------|-----------------|
| Contrast Ratio<br>(Center of screen)     |        | C/R              | Normal<br>θ $\mathbf{L,R}$ =0<br>θ $\mathbf{U,D}$ =0<br><br>Viewing<br>Angle | 2000          | 3000  | -             |                   | (3)<br>SR-3     |
| Response<br>Time                         | G-to-G | Tg               |                                                                              | -             | 8     | 16            | msec              | (5)<br>BM-7     |
| Luminance of White<br>(Center of screen) |        | Y <sub>L</sub>   |                                                                              | 400           | 450   | -             | cd/m <sup>2</sup> | (6)<br>SR-3     |
| Color<br>Chromaticity<br>(CIE 1931)      | Red    | Rx               |                                                                              | TYP.<br>-0.03 | 0.640 | TYP.<br>+0.03 |                   | (7),(8)<br>SR-3 |
|                                          |        | Ry               |                                                                              |               | 0.330 |               |                   |                 |
|                                          | Green  | Gx               |                                                                              |               | 0.300 |               |                   |                 |
|                                          |        | Gy               |                                                                              |               | 0.600 |               |                   |                 |
|                                          | Blue   | Bx               |                                                                              |               | 0.150 |               |                   |                 |
|                                          |        | By               |                                                                              |               | 0.060 |               |                   |                 |
|                                          | White  | Wx               |                                                                              |               | 0.280 |               |                   |                 |
|                                          |        | Wy               |                                                                              |               | 0.290 |               |                   |                 |
| Color Gamut                              |        | -                |                                                                              | -             | 72    | -             | %                 | (7)<br>SR-3     |
| Color Temperature                        |        | -                |                                                                              | -             | 10000 | -             | K                 | (7)<br>SR-3     |
| Viewing<br>Angle                         | Hor.   | θ <sub>L</sub>   | C/R≥10                                                                       | 75            | 89    | -             | Degree            | (8)<br>SR-3     |
|                                          |        | θ <sub>R</sub>   |                                                                              | 75            | 89    | -             |                   |                 |
|                                          | Ver.   | θ <sub>U</sub>   |                                                                              | 75            | 89    | -             |                   |                 |
|                                          |        | θ <sub>D</sub>   |                                                                              | 75            | 89    | -             |                   |                 |
| Brightness Uniformity<br>(9 Points)      |        | B <sub>uni</sub> |                                                                              | -             | -     | 25            | %                 | (4)<br>SR-3     |

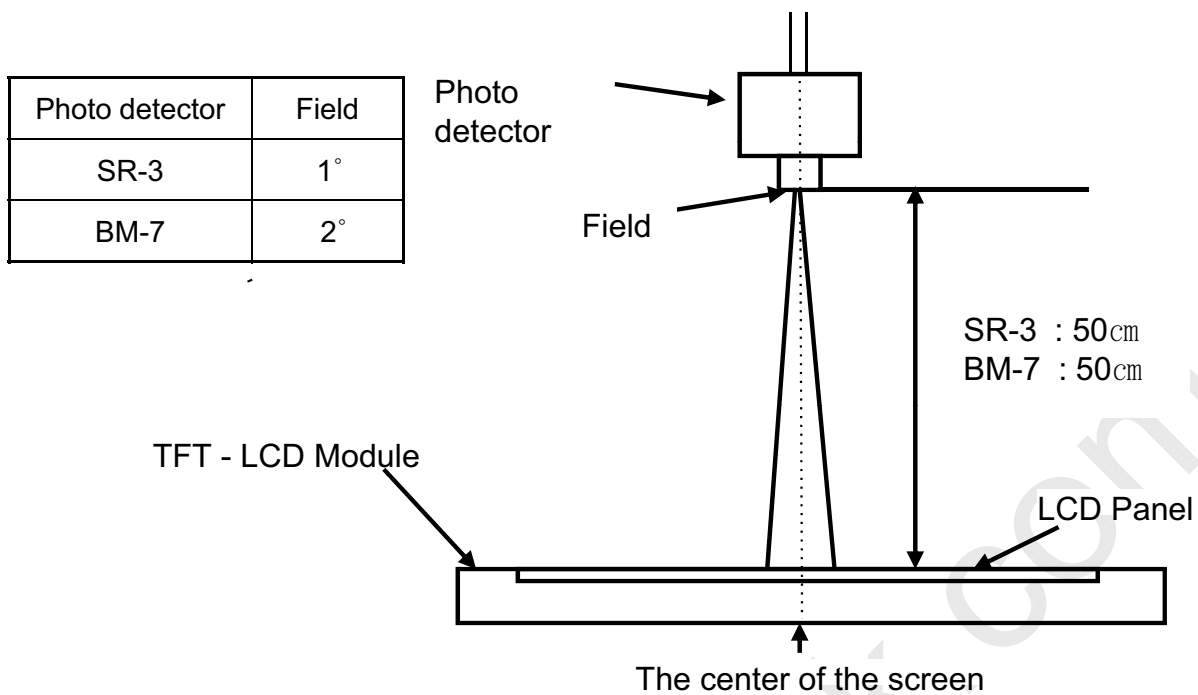
#### Note (1) Test Equipment Setup

The measurement should be executed in a stable, windless and dark room between 40min and 60min after lighting the backlight at the given temperature for stabilization of the backlight. This should be measured in the center of screen.

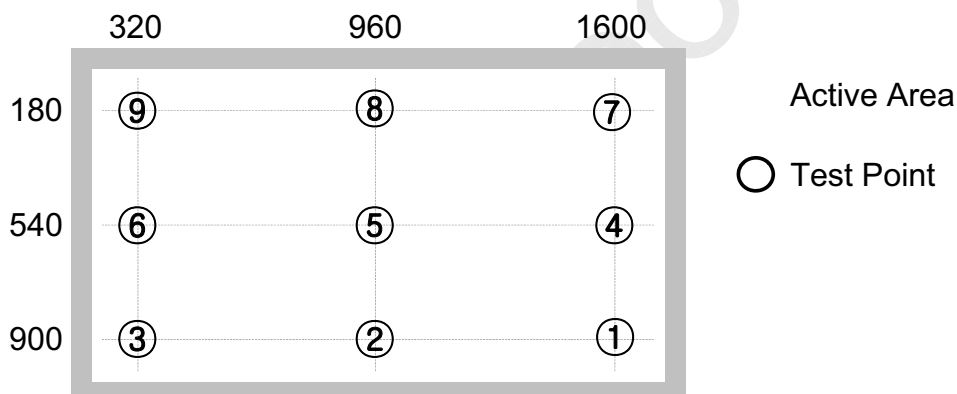
Single lamp current : 14.0 mA

Environment condition : Ta = 25 ± 2 °C

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Note (2) Definition of test point



Note (3) Definition of Contrast Ratio (C/R)

: Ratio of gray max (Gmax) &amp; gray min (Gmin) at the center point ⑤ of the panel

$$C/R = \frac{G_{\max}}{G_{\min}}$$

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note (4) Definition of 9 points brightness uniformity

$$B_{uni} = 100 * \frac{(B_{\max} - B_{\min})}{B_{\max}}$$

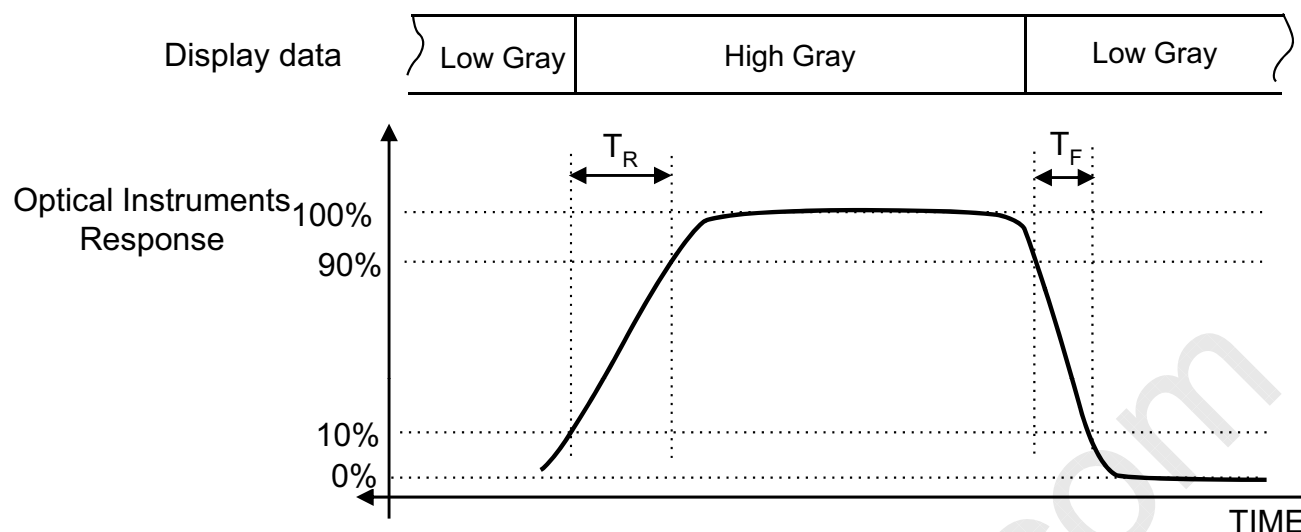
Bmax : Maximum brightness

Bmin : Minimum brightness



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Note (5) Definition of Response time : Average response time of all Gray to Gray



| Gray to Gray Response Time |      |           |            |            |            |             |             |             |             |             |     |
|----------------------------|------|-----------|------------|------------|------------|-------------|-------------|-------------|-------------|-------------|-----|
|                            | Gray | End       |            |            |            |             |             |             |             |             |     |
|                            |      | 0         | 31         | 63         | 95         | 127         | 159         | 191         | 223         | 255         |     |
| Start                      | 0    |           | Tr(0-31)   | Tr(0-63)   | Tr(0-95)   | Tr(0-127)   | Tr(0-159)   | Tr(0-191)   | Tr(0-223)   | Tr(0-255)   | Ton |
|                            | 31   | Tf(31-0)  |            | Tr(31-63)  | Tr(31-95)  | Tr(31-127)  | Tr(31-159)  | Tr(31-191)  | Tr(31-223)  | Tr(31-255)  |     |
|                            | 63   | Tf(63-0)  | Tf(63-31)  |            | Tr(63-95)  | Tr(63-127)  | Tr(63-159)  | Tr(63-191)  | Tr(63-223)  | Tr(63-255)  |     |
|                            | 95   | Tf(95-0)  | Tf(95-31)  | Tf(95-63)  |            | Tr(95-127)  | Tr(95-159)  | Tr(95-191)  | Tr(95-223)  | Tr(95-255)  |     |
|                            | 127  | Tf(127-0) | Tf(127-31) | Tf(127-63) | Tf(127-95) |             | Tr(127-159) | Tr(127-191) | Tr(127-223) | Tr(127-255) |     |
|                            | 159  | Tf(159-0) | Tf(159-31) | Tf(159-63) | Tf(159-95) | Tf(159-127) |             | Tr(159-191) | Tr(159-223) | Tr(159-255) |     |
|                            | 191  | Tf(191-0) | Tf(191-31) | Tf(191-63) | Tf(191-95) | Tf(191-127) | Tf(191-159) |             | Tr(191-223) | Tr(191-255) |     |
|                            | 223  | Tf(223-0) | Tf(223-31) | Tf(223-63) | Tf(223-95) | Tf(223-127) | Tf(223-159) | Tf(223-191) |             | Tr(223-255) |     |
|                            | 255  | Tf(255-0) | Tf(255-31) | Tf(255-63) | Tf(255-95) | Tf(255-127) | Tf(255-159) | Tf(255-191) | Tf(255-223) |             |     |
|                            |      | Toff      |            |            |            |             |             |             |             |             |     |

$T^*(X-Y)$  : Response time from level of gray(X) to level of gray(Y)

**Response time Definition** =  $\sum [T^*(X-Y)] / 72$

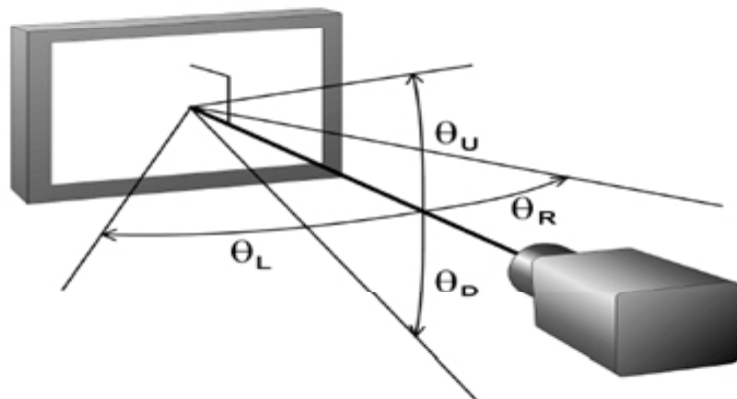
Note (6) Definition of Luminance of White : Luminance of white at center point ⑤

Note (7) Definition of Color Chromaticity (CIE 1931)

Color coordinate of Red, Green, Blue & White at center point ⑤

Note (8) Definition of Viewing Angle

: Viewing angle range (C/R ≥ 10)



## 4. Electrical Characteristics

### 4.1 TFT LCD Module

The connector for display data & timing signal should be connected.

$T_a = 25^{\circ}\text{C} \pm 2^{\circ}\text{C}$

| Item                    |               | Symbol     | Min.  | Typ.  | Max. | Unit | Note    |
|-------------------------|---------------|------------|-------|-------|------|------|---------|
| Voltage of Power Supply |               | $V_{DD}$   | 10.8  | 12.0  | 13.2 | V    | (1)     |
| Current of Power Supply | (a) Black     | $I_{DD}$   | -     | 800   | -    | mA   | (2),(3) |
|                         | (b) White     |            | -     | 1400  | -    | mA   |         |
|                         | (c) N-Pattern |            | -     | 1400  | 1600 | mA   |         |
| Vsync Frequency         |               | $f_V$      | -     | 60.0  | -    | Hz   |         |
| Hsync Frequency         |               | $f_H$      | 48    | 67.5  | 72   | kHz  |         |
| Main Frequency          |               | $f_{DCLK}$ | 130.0 | 148.5 | 160  | MHz  |         |
| Rush Current            |               | $I_{RUSH}$ | -     | -     | 3.0  | A    | (4)     |

Note (1) The ripple voltage should be controlled under 10% of  $V_{DD}$ .

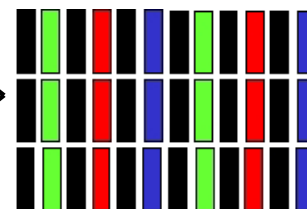
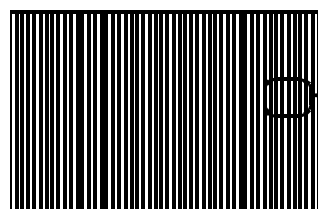
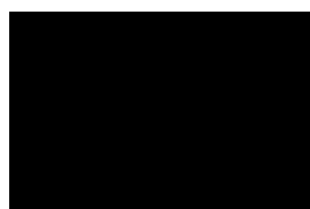
(2)  $f_V = 60\text{Hz}$ ,  $f_{DCLK} = 148.5\text{MHz}$ ,  $V_{DD} = 12.0\text{V}$ , DC Current.

(3) Power dissipation check pattern (LCD Module only)

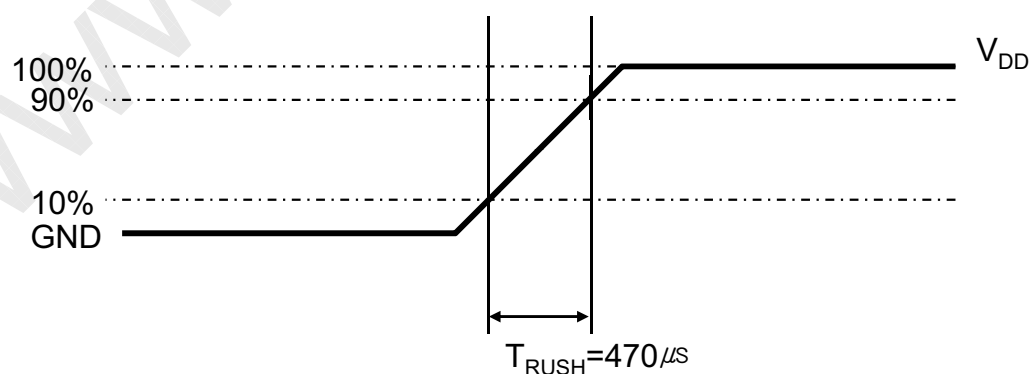
a) Black Pattern

b) White Pattern

c) N-Pattern



#### (4) Measurement Conditions



Rush Current  $I_{RUSH}$  can be measured when  $T_{RUSH}$  is  $470 \mu\text{s}$ .

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## 4.2 Back Light Unit

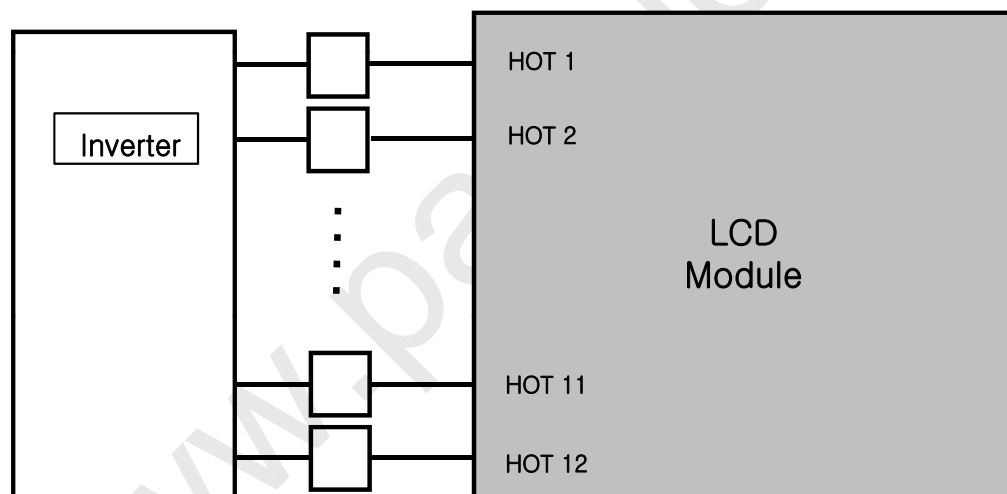
The backlight unit contains 12 direct-lighting type CCFTs (Cold Cathode Fluorescent Tube). The characteristics of lamps are shown in the following tables.

 $T_a = 25 \pm 2^\circ\text{C}$ 

| Item                | Symbol | Min.                                                                             | Typ. | Max. | Unit  | Note |
|---------------------|--------|----------------------------------------------------------------------------------|------|------|-------|------|
| Lamp Current        | $I_L$  | 11.0                                                                             | 14.0 | 15.0 | mArms |      |
| Lamp Voltage        | $V_L$  | 995 $\pm$ 7% (IL : 11mA)<br>950 $\pm$ 7% (IL : 14mA)<br>935 $\pm$ 7% (IL : 15mA) |      |      | Vrms  |      |
| Operating Life Time | Hr     | 50,000                                                                           | -    | -    | Hour  | (1)  |

Note (1) It is defined as the time to take until the brightness reduces to 50% of its original value.

[Operating condition :  $T_a = 25 \pm 2^\circ\text{C}$ ,  $I_L = 14.0$  mArms, For single lamp only]



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## 4.3 Inverter Input Condition &amp; Specification

| Items            | Symbol             | Conditions                                         | Specifications |      |      | Unit  | Note                 |
|------------------|--------------------|----------------------------------------------------|----------------|------|------|-------|----------------------|
|                  |                    |                                                    | Min.           | Typ. | Max. |       |                      |
| Input Voltage    | V <sub>in</sub>    | -                                                  | 22             | 24   | 26   | V     | Ta=25±2 °C           |
| Input Current    | I <sub>in</sub>    | V <sub>in</sub> = 24.0V<br>V <sub>dim</sub> = 3.3V | -              | -    | 9.09 | Adc   | Initial turn on      |
| Lamp Current     | I <sub>O,MAX</sub> | V <sub>dim</sub> = 3.3V                            | 13.3           | 14.0 | 14.7 | mArms | After 1 hour Warm-up |
| Frequency        | F <sub>LAMP</sub>  | V <sub>in</sub> = 24.0V                            | 42             | 43.5 | 45   | kHz   |                      |
| Backlight On/Off | ON                 | V <sub>in</sub> = 24.0V                            | 2.4            | -    | 5.25 | V     | -                    |
|                  | OFF                | V <sub>in</sub> = 24.0V                            | 0              | -    | 0.8  |       |                      |
| Dimming Control  | V <sub>DIM</sub>   | Max. Lum.                                          | 3.3            | -    | -    | V     | -                    |
|                  |                    | Min. Lum.                                          | -              | -    | 0    |       |                      |

Note (1) Power Consumption is measured at 450[cd/m<sup>2</sup>] of luminance condition which is the typical luminance value. Lamp Current is measured at the point before Lamp.

※ Additional Appendix for supply current

| Items         | Symbol                     | Conditions                                               | Specifications |      |      | Unit |
|---------------|----------------------------|----------------------------------------------------------|----------------|------|------|------|
|               |                            |                                                          | Min.           | Typ. | Max. |      |
| Input Current | I <sub>IN_overshoot</sub>  | V <sub>IN</sub> =24V, DIM=3.3V<br>(Within 1hr at BLU ON) | -              | 7.78 | 8.30 | Adc  |
|               | I <sub>IN_saturation</sub> | V <sub>IN</sub> =24V, DIM=3.3V<br>(After 1hr Aging)      | -              | 6.75 | 7.20 |      |

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## 5. Input Terminal Pin Assignment

### 5.1 Input Signal & Power

Connector : FI-RE51S-HF (JAE)

| PIN No. | Description           |                  | PIN No. | Description            |                  |
|---------|-----------------------|------------------|---------|------------------------|------------------|
| 1       | Vdd (12V)             |                  | 26      | Even<br>LVDS<br>Signal | RE[0]P           |
| 2       | Vdd (12V)             |                  | 27      |                        | RE[1]N           |
| 3       | Vdd (12V)             |                  | 28      |                        | RE[1]P           |
| 4       | Vdd (12V)             |                  | 29      |                        | RE[2]N           |
| 5       | Vdd (12V)             |                  | 30      |                        | RE[2]P           |
| 6       | No Connection(1)      |                  | 31      |                        | GND              |
| 7       | GND                   |                  | 32      |                        | RECLK-           |
| 8       | GND                   |                  | 33      |                        | RECLK+           |
| 9       | GND                   |                  | 34      |                        | GND              |
| 10      | Odd<br>LVDS<br>Signal | RO[0]N           | 35      |                        | RE[3]N           |
| 11      |                       | RO[0]P           | 36      |                        | RE[3]P           |
| 12      |                       | RO[1]N           | 37      |                        | No Connection(1) |
| 13      |                       | RO[1]P           | 38      |                        | No Connection(1) |
| 14      |                       | RO[2]N           | 39      | GND                    |                  |
| 15      |                       | RO[2]P           | 40      | No Connection (1)      |                  |
| 16      |                       | GND              | 41      | No Connection(1)       |                  |
| 17      |                       | ROCLK-           | 42      | No Connection (1)      |                  |
| 18      |                       | ROCLK+           | 43      | No Connection(1)       |                  |
| 19      |                       | GND              | 44      | No Connection (1)      |                  |
| 20      |                       | RO[3]N           | 45      | LVDS_SEL (2)           |                  |
| 21      |                       | RO[3]P           | 46      | No Connection(1)       |                  |
| 22      |                       | No Connection(1) | 47      | No Connection(1)       |                  |
| 23      |                       | No Connection(1) | 48      | No Connection(1)       |                  |
| 24      | GND                   |                  | 49      | No Connection (1)      |                  |
| 25      | Even LVDS             | RE[0]N           | 50      | No Connection(1)       |                  |
|         |                       |                  | 51      | No Connection (1)      |                  |

Note(1) No Connection : These pins are only used for SAMSUNG internal purpose.

(2) LVDS Option : High (3.3V) → Normal LVDS format

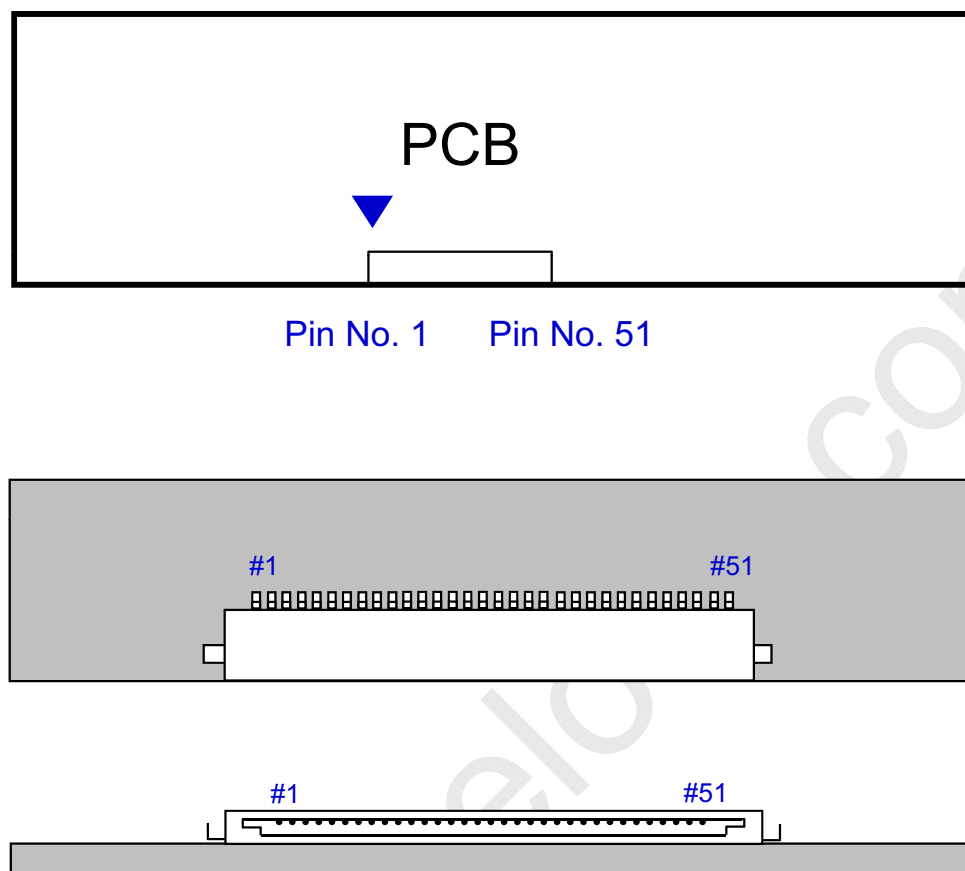
: Low (GND) or Open (N.C) → JEIDA LVDS format

Sequence : On = VDD ≥ LVDS Option ≥ Interface Signal

Off = Interface Signal ≥ LVDS Option ≥ VDD

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Note (3) LVDS Connector

**Fig. Connector diagram**

- All GND pins should be connected together and also be connected to the LCD's metal chassis.
- All power input pins should be connected together.
- All N.C pins should be separated from other signal or power.

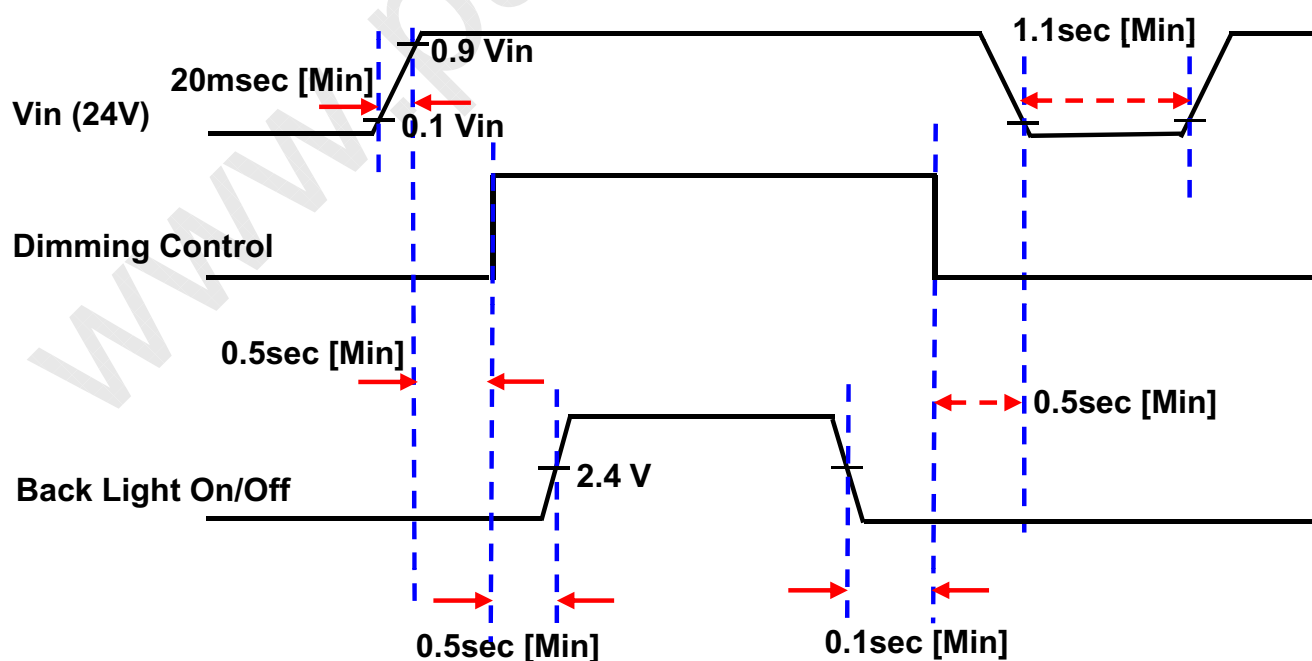
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## 5.2 Inverter Input Pin Configuration

Connector : YEON HO, 20022WR-14B1

| Pin No. | Pin Configuration(FUNCTION)                        |
|---------|----------------------------------------------------|
| 1       | Vin (24V)                                          |
| 2       | Vin (24V)                                          |
| 3       | Vin (24V)                                          |
| 4       | Vin (24V)                                          |
| 5       | Vin (24V)                                          |
| 6       | GND                                                |
| 7       | GND                                                |
| 8       | GND                                                |
| 9       | GND                                                |
| 10      | GND                                                |
| 11      | No connection                                      |
| 12      | Backlight On /Off [On: 2.4 ~ 5.25V, Off: 0 ~ 0.8V] |
| 13      | Internal Dimming [0V: Min, 3.3V: Max]              |
| 14      | No Connection                                      |

## 5.3 Inverter Input Power Sequence



## 5.4 LVDS Interface

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- LVDS Receiver : Tcon (merged)
- Data Format (JEIDA & Normal)

Default LVDS Option : JEIDA

|             | LVDS pin     | JEIDA -DATA | VESA -DATA |
|-------------|--------------|-------------|------------|
| TxOUT/RxIN0 | TxIN/RxOUT0  | R2          | R0         |
|             | TxIN/RxOUT1  | R3          | R1         |
|             | TxIN/RxOUT2  | R4          | R2         |
|             | TxIN/RxOUT3  | R5          | R3         |
|             | TxIN/RxOUT4  | R6          | R4         |
|             | TxIN/RxOUT6  | R7          | R5         |
|             | TxIN/RxOUT7  | G2          | G0         |
| TxOUT/RxIN1 | TxIN/RxOUT8  | G3          | G1         |
|             | TxIN/RxOUT9  | G4          | G2         |
|             | TxIN/RxOUT12 | G5          | G3         |
|             | TxIN/RxOUT13 | G6          | G4         |
|             | TxIN/RxOUT14 | G7          | G5         |
|             | TxIN/RxOUT15 | B2          | B0         |
|             | TxIN/RxOUT18 | B3          | B1         |
| TxOUT/RxIN2 | TxIN/RxOUT19 | B4          | B2         |
|             | TxIN/RxOUT20 | B5          | B3         |
|             | TxIN/RxOUT21 | B6          | B4         |
|             | TxIN/RxOUT22 | B7          | B5         |
|             | TxIN/RxOUT24 | HSYNC       | HSYNC      |
|             | TxIN/RxOUT25 | VSYNC       | VSYNC      |
|             | TxIN/RxOUT26 | DEN         | DEN        |
| TxOUT/RxIN3 | TxIN/RxOUT27 | R0          | R6         |
|             | TxIN/RxOUT5  | R1          | R7         |
|             | TxIN/RxOUT10 | G0          | G6         |
|             | TxIN/RxOUT11 | G1          | G7         |
|             | TxIN/RxOUT16 | B0          | B6         |
|             | TxIN/RxOUT17 | B1          | B7         |
|             | TxIN/RxOUT23 | RESERVED    | RESERVED   |



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## 5.5 Input Signals, Basic Display Colors and Gray Scale of Each Color

| COLOR                        | DISPLAY<br>(8bit) | DATA SIGNAL |    |    |    |    |    |    |    |    |       |    |    |    |    |    |    |    |      |    |    |    |    |    |    |             |      | GRAY<br>SCALE<br>LEVEL |
|------------------------------|-------------------|-------------|----|----|----|----|----|----|----|----|-------|----|----|----|----|----|----|----|------|----|----|----|----|----|----|-------------|------|------------------------|
|                              |                   | RED         |    |    |    |    |    |    |    |    | GREEN |    |    |    |    |    |    |    | BLUE |    |    |    |    |    |    |             |      |                        |
|                              |                   | R0          | R1 | R2 | R3 | R4 | R5 | R6 | R7 | G0 | G1    | G2 | G3 | G4 | G5 | G6 | G7 | B0 | B1   | B2 | B3 | B4 | B5 | B6 | B7 |             |      |                        |
| BASIC<br>COLOR               | BLACK             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | -    |                        |
|                              | BLUE              | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1           | -    |                        |
|                              | GREEN             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | -    |                        |
|                              | CYAN              | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1           | -    |                        |
|                              | RED               | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | -    |                        |
|                              | MAGENTA           | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1           | -    |                        |
|                              | YELLOW            | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | -    |                        |
|                              | WHITE             | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1           | -    |                        |
| GRAY<br>SCALE<br>OF<br>RED   | BLACK             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | R0   |                        |
|                              | DARK<br>↑         | 1           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | R1   |                        |
|                              |                   | 0           | 1  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | R2   |                        |
|                              |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :     | :  | :  | :  | :  |    |    | :  | :    | :  | :  | :  | :  |    |    | R3~<br>R252 |      |                        |
|                              |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :     | :  | :  | :  | :  |    |    | :  | :    | :  | :  | :  | :  |    |    |             |      |                        |
|                              | ↓<br>LIGHT        | 1           | 0  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | R253 |                        |
|                              |                   | 0           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | R254 |                        |
|                              | RED               | 1           | 1  | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | R255 |                        |
| GRAY<br>SCALE<br>OF<br>GREEN | BLACK             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | G0   |                        |
|                              | DARK<br>↑         | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | G1   |                        |
|                              |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | G2   |                        |
|                              |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :     | :  | :  | :  | :  |    |    | :  | :    | :  | :  | :  | :  |    |    | G3~<br>G252 |      |                        |
|                              |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :     | :  | :  | :  | :  |    |    | :  | :    | :  | :  | :  | :  |    |    |             |      |                        |
|                              | ↓<br>LIGHT        | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0     | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | G253 |                        |
|                              |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | G254 |                        |
|                              | GREEN             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1     | 1  | 1  | 1  | 1  | 1  | 1  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | G255 |                        |
| GRAY<br>SCALE<br>OF<br>BLUE  | BLACK             | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | B0   |                        |
|                              | DARK<br>↑         | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | B1   |                        |
|                              |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1    | 0  | 0  | 0  | 0  | 0  | 0  | 0           | B2   |                        |
|                              |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :     | :  | :  | :  | :  |    |    | :  | :    | :  | :  | :  | :  |    |    | B3~<br>B252 |      |                        |
|                              |                   | :           | :  | :  | :  | :  | :  |    |    | :  | :     | :  | :  | :  | :  |    |    | :  | :    | :  | :  | :  | :  |    |    |             |      |                        |
|                              | ↓<br>LIGHT        | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 0    | 1  | 1  | 1  | 1  | 1  | 1  | 1           | B253 |                        |
|                              |                   | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1           | B254 |                        |
|                              | BLUE              | 0           | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0  | 0     | 0  | 0  | 0  | 0  | 0  | 0  | 1  | 1    | 1  | 1  | 1  | 1  | 1  | 1  | 1           | B255 |                        |

Note) Definition of Gray :

Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

Input Signal : 0 = Low level voltage, 1 = High level voltage

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## 6. Interface Timing

### 6.1 Timing Parameters (DE only mode)

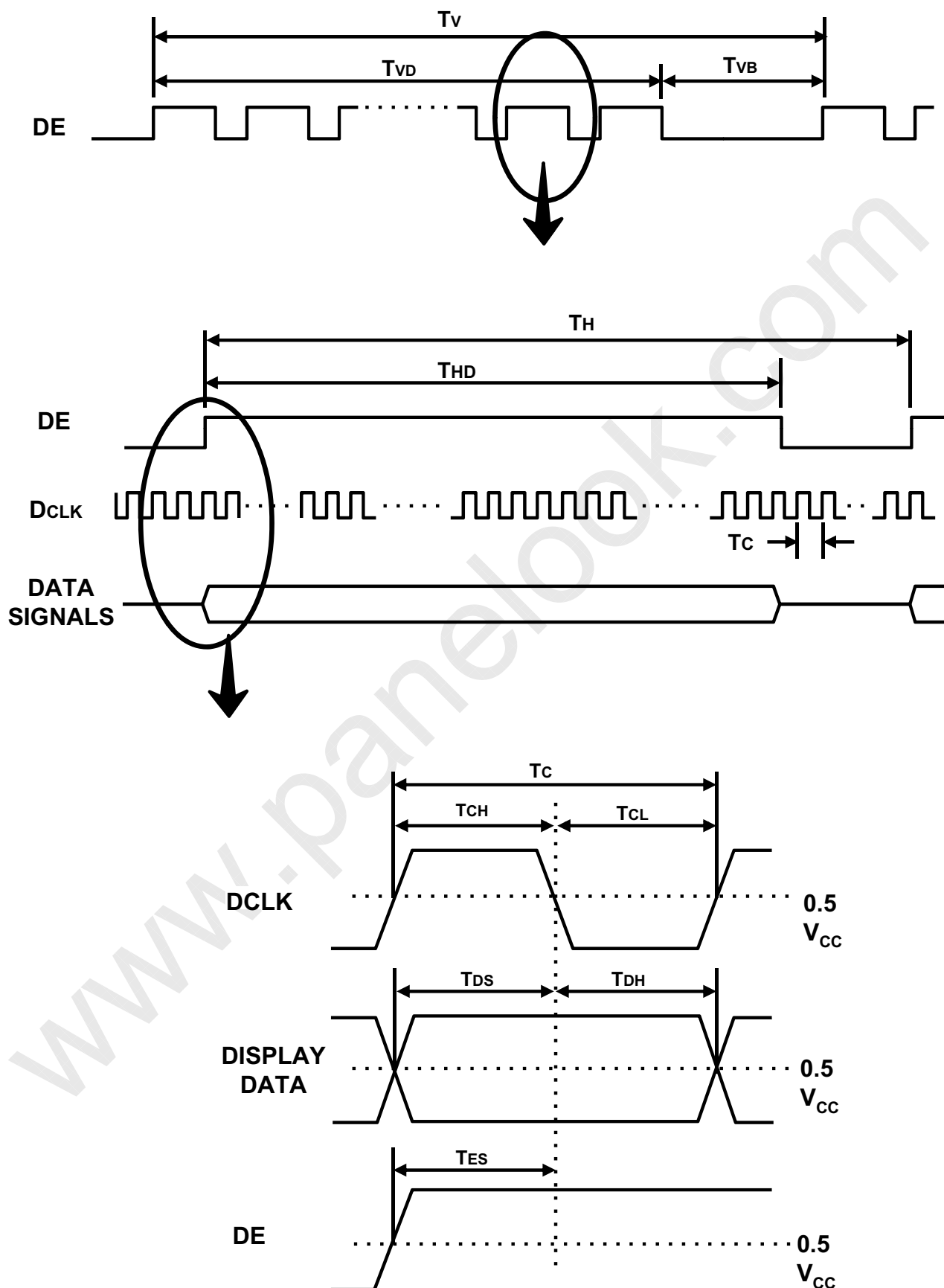
| Signal                  | Item                  | Symbol   | Min. | Typ.  | Max. | Unit   | Note |
|-------------------------|-----------------------|----------|------|-------|------|--------|------|
| Clock                   | Frequency             | $1/T_C$  | 130  | 148.5 | 160  | MHz    | -    |
| Hsync                   |                       | $F_H$    | 48.0 | 67.5  | 72.0 | KHz    | -    |
| Vsync                   |                       | $F_V$    | 45   | 60    | 65   | Hz     | -    |
| Vertical Display Term   | Active Display Period | $T_{VD}$ | -    | 1080  | -    | Lines  | -    |
|                         | Vertical Total        | $T_V$    | 1092 | 1125  | 1158 | Lines  | -    |
| Horizontal Display Term | Active Display Period | $T_{HD}$ | -    | 1920  | -    | Clocks | -    |
|                         | Horizontal Total      | $T_H$    | 2090 | 2200  | 2350 | Clocks | -    |

Note) This product is DE only mode. The input of Hsync & Vsync signal does not have an effect on normal operation.

Test Point : TTL control signal and CLK at LVDS Tx input terminal in system

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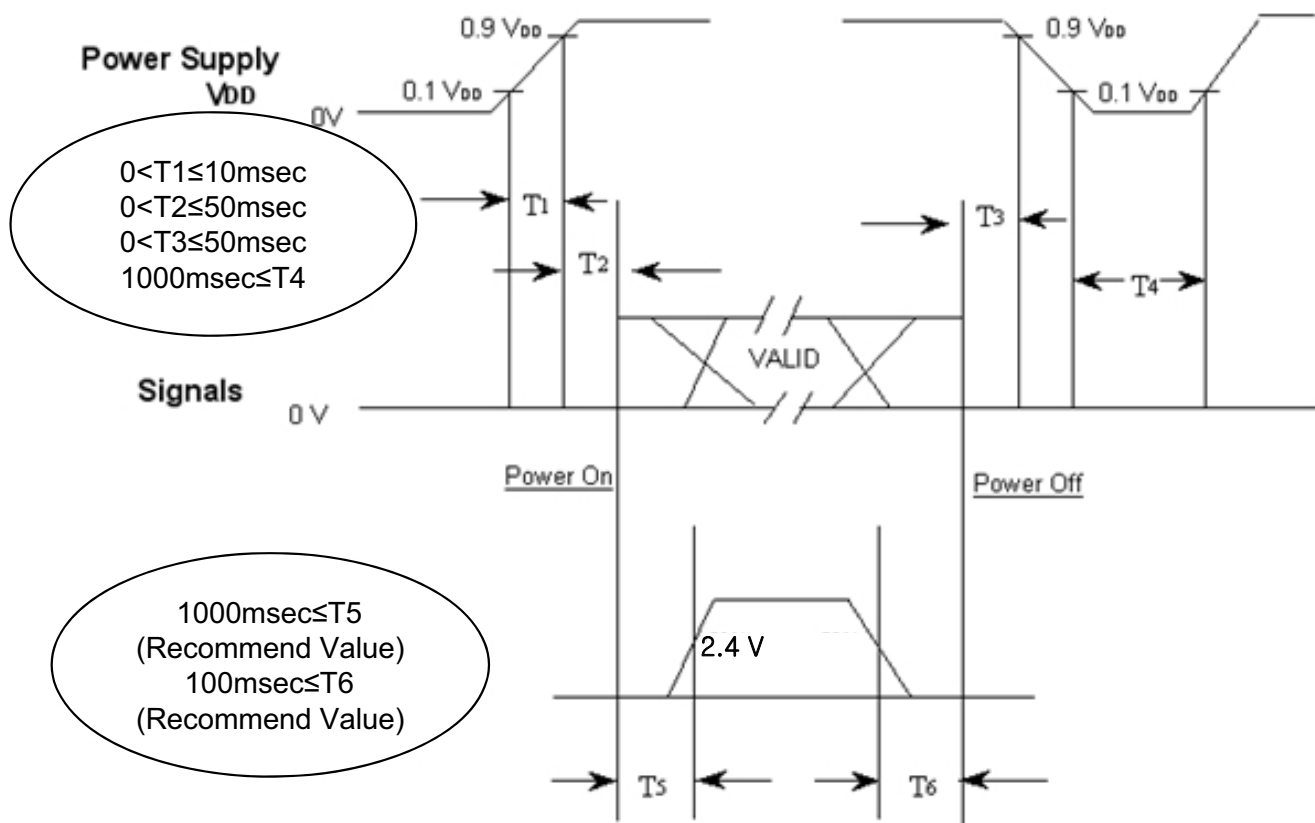
## 6.2 Timing diagrams of interface signal (DE only mode)



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### 6.3 Power ON/OFF Sequence

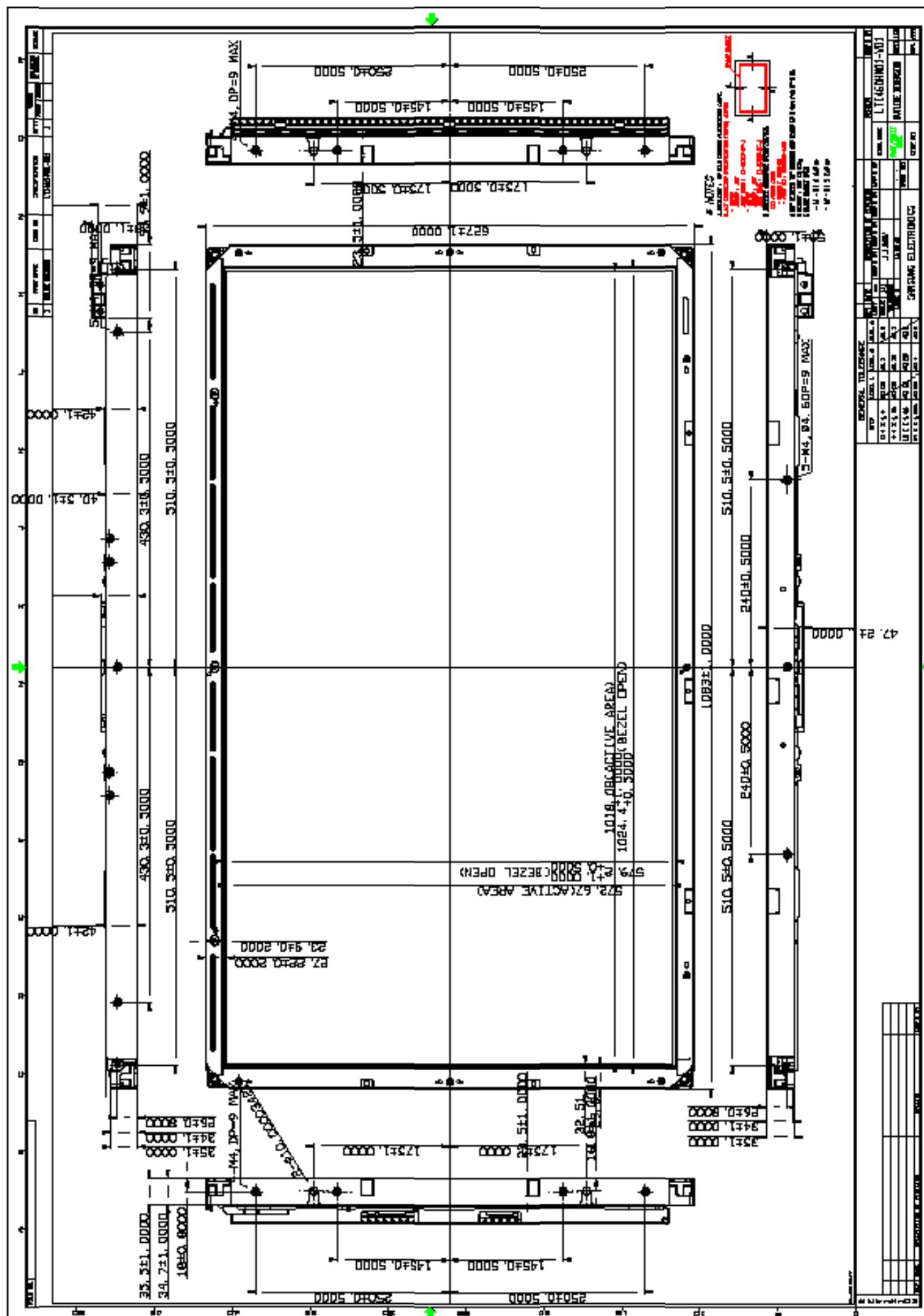
To prevent a latch-up or DC operation of the LCD Module, the power on/off sequence should be as the diagram below.



- $T1$  :  $V_{DD}$  rising time from 10% to 90%  
 $T2$  : The time from  $V_{DD}$  to valid data at power ON.  
 $T3$  : The time from valid data off to  $V_{DD}$  off at power Off.  
 $T4$  :  $V_{DD}$  off time for Windows restart  
 $T5$  : The time from valid data to B/L enable at power ON.  
 $T6$  : The time from valid data off to B/L disable at power Off.

- The supply voltage of the external system for the Module input should be the same as the definition of  $V_{DD}$ .
- Apply the lamp voltage within the LCD operation range. When the backlight turns on before the LCD operation or the LCD turns off before the backlight turns off, the display may momentarily show abnormal screen.
- In case of  $V_{DD}$  = off level, please keep the level of input signals low or keep a high impedance.
- $T4$  should be measured after the Module has been fully discharged between power off and on period.
- Interface signal should not be kept at high impedance when the power is on.

## 7. Outline Dimension (Front View)





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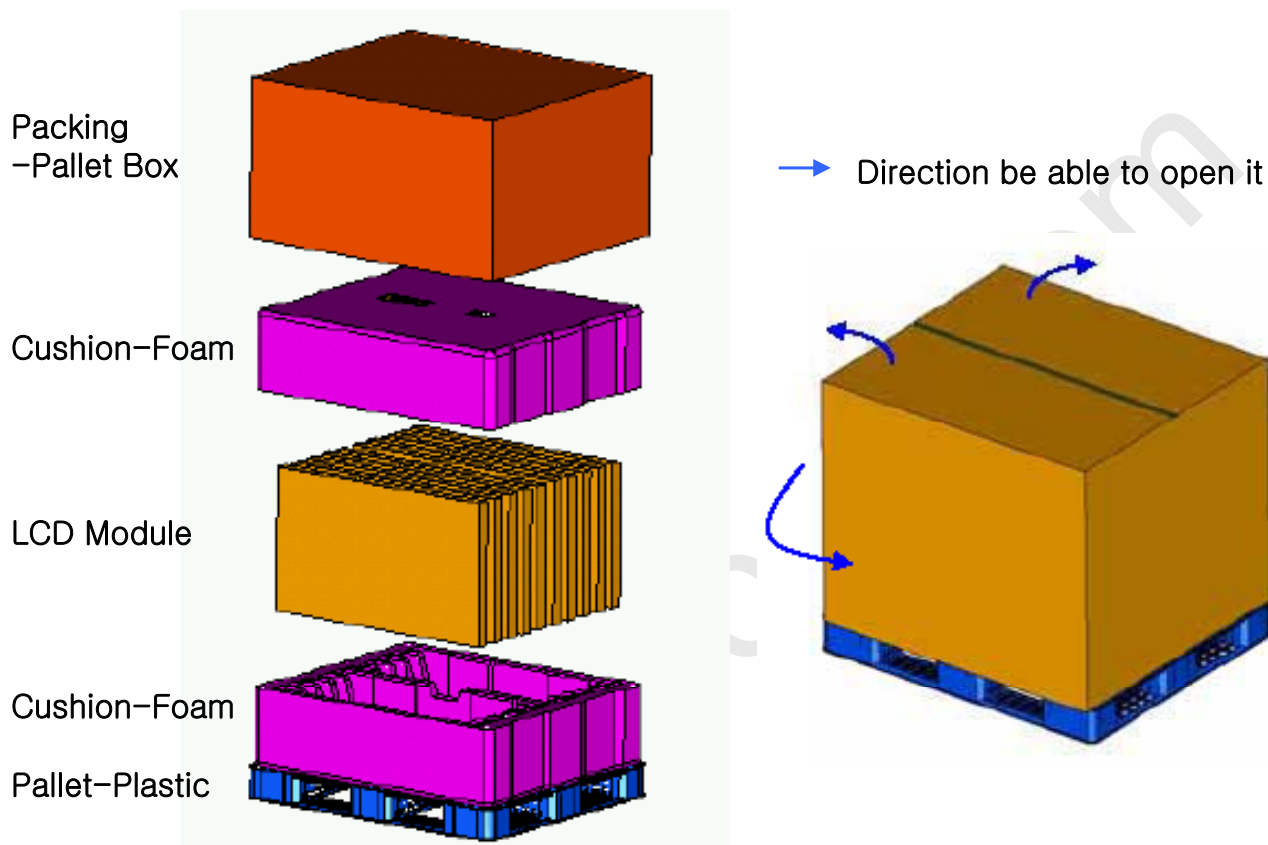
## 8. PACKING

### 8.1 CARTON (Internal Package)

#### (1) Packing Form

Corrugated fiberboard box and corrugated cardboard as shock absorber

#### (2) Packing Method



### 8.2 Packing Specification

| Item                | Specification               | Remark                                                                                                                                                                      |
|---------------------|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LCD Packing         | 10ea / (Packing-Pallet Box) | 1. 115 Kg / LCD (10ea)<br>2. 10 Kg / Cushion-pallet (2ea)<br>3. 8 Kg / Packing-Pallet Box (1ea)<br>4. Cushion-pallet Material : EPS<br>5. Packing-Pallet Box Material : DW4 |
| Pallet              | 1Box / Pallet               | 1. Pallet weight = 8.8kg                                                                                                                                                    |
| Packing Direction   | Vertical                    |                                                                                                                                                                             |
| Total Pallet Size   | H x V x height              | 1270mm(H) x 1150mm(V) x 844mm(height)                                                                                                                                       |
| Total Pallet Weight | 141.8 kg                    | Pallet(8.8kg) + Module(115 kg) + Cushion(10kg) + Pallet-BOX(8kg)                                                                                                            |

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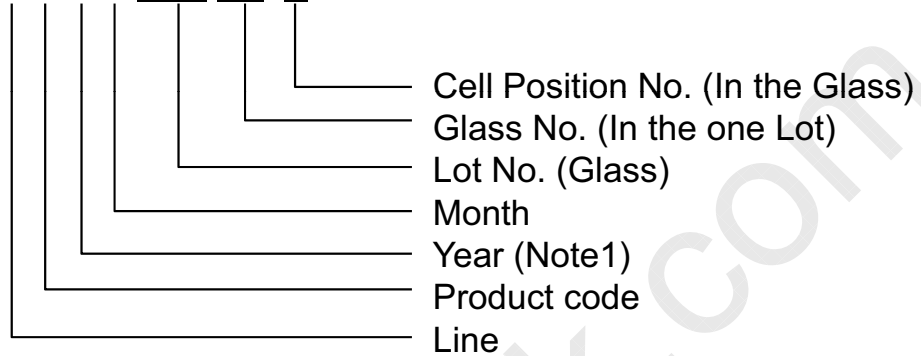
### 9. MARKING & OTHERS

A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

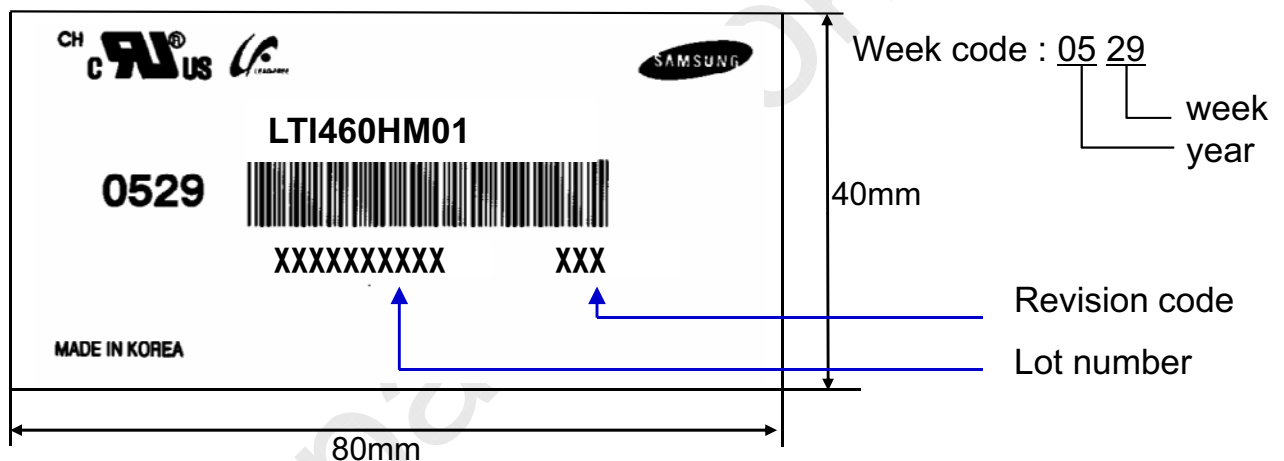
(1) Part number : LTI460HM01

(2) Revision: Three letters

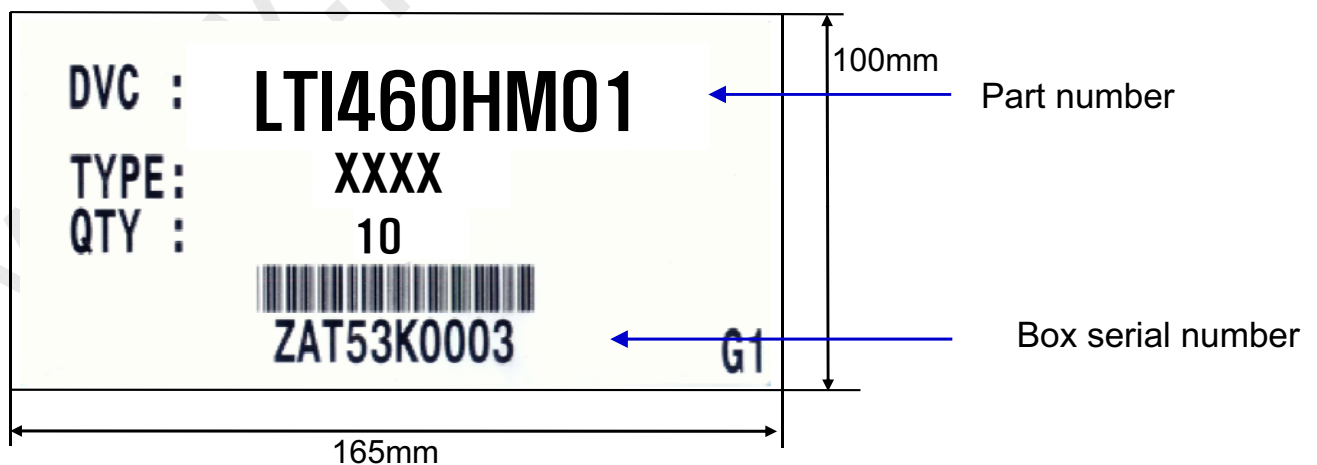
(3) Lot number : X X X X XXX XX X



(4) Nameplate Indication



(5) Packing box attach



(6) Others

1. After service part

Lamps cannot be replaced because of the narrow bezel structure.



**Samsung Confidential****9.3 Packing Storage condition**

| ITEM                | Unit                                                                                                                                                                                                                                                                                                                                                                                           | Min. | Max. |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|
| Storage Temperature | (℃)                                                                                                                                                                                                                                                                                                                                                                                            | 5    | 40   |
| Storage Humidity    | (%rH)                                                                                                                                                                                                                                                                                                                                                                                          | 35   | 75   |
| Storage life        | 12 months                                                                                                                                                                                                                                                                                                                                                                                      |      |      |
| Storage Condition   | <ul style="list-style-type: none"><li>- Prohibit direct sunlight</li><li>- Ventilation in storehouse and Control changing temperature is within limits of environment</li><li>- Put it on pallet, don't put it on floor. and store them with removing from wall.</li><li>- Don't wet Out-BOX and avoid rain.</li><li>- Without condensation.</li><li>- Etc. Avoid harmful Condition.</li></ul> |      |      |

**9.4 Packing long-term Storage guide**

|                            |                                                                                                                             |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------|
| Long -term Storage Process | More than 3months Storage or Low temp. Delivery/under 5℃ Storage,<br>→On the 20℃ 50%rH Condition , More than 10hrs release. |
|----------------------------|-----------------------------------------------------------------------------------------------------------------------------|

## 10. General Precautions

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### 10.1 Handling

- (a) When the Module is assembled, it should be attached to the system firmly using all mounting holes. Be careful not to twist and bend the Module.
- (b) Because the inverter use high voltage, it should be disconnected from power before it is assembled or disassembled.
- (c) Refrain from strong mechanical shock and / or any force to the Module.  
In addition to damage, this may cause improper operation or damage to the Module and CCFT backlight.
- (d) Note that polarizers are very fragile and could be damage easily.  
Do not press or scratch the surface harder than a HB pencil lead.
- (e) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining or discoloration may occur.
- (f) If the surface of the polarizer is dirty, clean it using absorbent cotton or soft cloth.
- (g) Desirable cleaners are water, IPA(Isopropyl Alcohol) or Hexane.  
Do not use Ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanent damage to the polarizer due to chemical reaction.
- (h) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away with soap thoroughly.
- (i) Protect the Module from static, or the CMOS Gate Array IC would be damaged.
- (j) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (k) Do not disassemble the Module.
- (l) Do not adjust the variable resistor located on the Module.
- (m) Protection film for polarizer on the Module should be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (n) Pins of I/F connector should not be touched directly with bare hands.

## 10.2 Storage

- (a) Do not leave the Module in high temperature, and high humidity for a long time. It is highly recommended to store the Module with temperature from 0 to 35 °C and relative humidity of less than 70%.
- (b) Do not store the TFT-LCD Module in direct sunlight.
- (c) The Module should be stored in a dark place. It is prohibited to apply sunlight or fluorescent light in storing.

## 10.3 Operation

- (a) Do not connect or disconnect the Module in the "Power On" condition.
- (b) Power supply should always be turned on/off by the "Power on/off sequence"
- (c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference should be done by system manufacturers.  
Grounding and shielding methods may be important to minimize the interference.
- (d) The cable between the backlight connector and its inverter power supply should be connected directly with a minimized length. A longer cable between the backlight and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage(Vs).

## 10.4 Operation Condition Guide

- (a) The LCD product should be operated under normal conditions.  
Normal condition is defined as below;
  - Temperature :  $20 \pm 15^{\circ}\text{C}$
  - Humidity :  $55 \pm 20\%$
  - Display pattern : continually changing pattern (Not stationary)
- (b) If the product will be used in extreme conditions such as high temperature, humidity, display patterns or operation time etc., It is strongly recommended to contact SEC for Application engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at Airports, Transit Stations, Banks, Stock market, and Controlling systems.



## 10.5 Others

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- (a) Ultra-violet ray filter is necessary for outdoor operation.
- (b) Module should be turned clockwise (regular front view perspective) when used in portrait mode
- (c) Avoid condensation of water. It may result in improper operation or disconnection of electrode.
- (d) Do not exceed the absolute maximum rating value. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on)  
Otherwise the Module may be damaged.
- (e) If the Module keeps displaying the same pattern for a long period of time, the image may be "sticked" to the screen.  
To avoid image sticking, it is recommended to use a screen saver.
- (f) This Module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.
- (g) Please contact SEC in advance when you display the same pattern for a long time.